NORMARC 7050

MARKER BEACON

Transmitter

NAVIA AVIATION

Normarc®

NAVIA AVIATION

TRANSMITTER DESCRIPTION

1 TX 1373A Transmitter

1.1 General Description

TX 1373A is a module designed to transmit Marker Beacon signals. An on board oscillator working at 75 MHz provides an output of app.0 dBm that is used as input to the Power Amplifier (PA). The level of this input signal is adjusted to an output of app. +20 dBm. The Power Amplifier is capable of delivering up to 4W carrier power at the cabinet output.

Unwanted frequencies are removed by a lowpass filter after the PA. Part of the signal out of the PA is tapped off to be demodulated and used for feedback and self test purposes. Demodulation is done by a mixer with a linear detector.

The audio signals are generated in the LF circuitry mainly by a Field Programmable Gate Array (FPGA). Inner, Middle or Outer Marker is selected by straps.

1.1.1 Block diagram

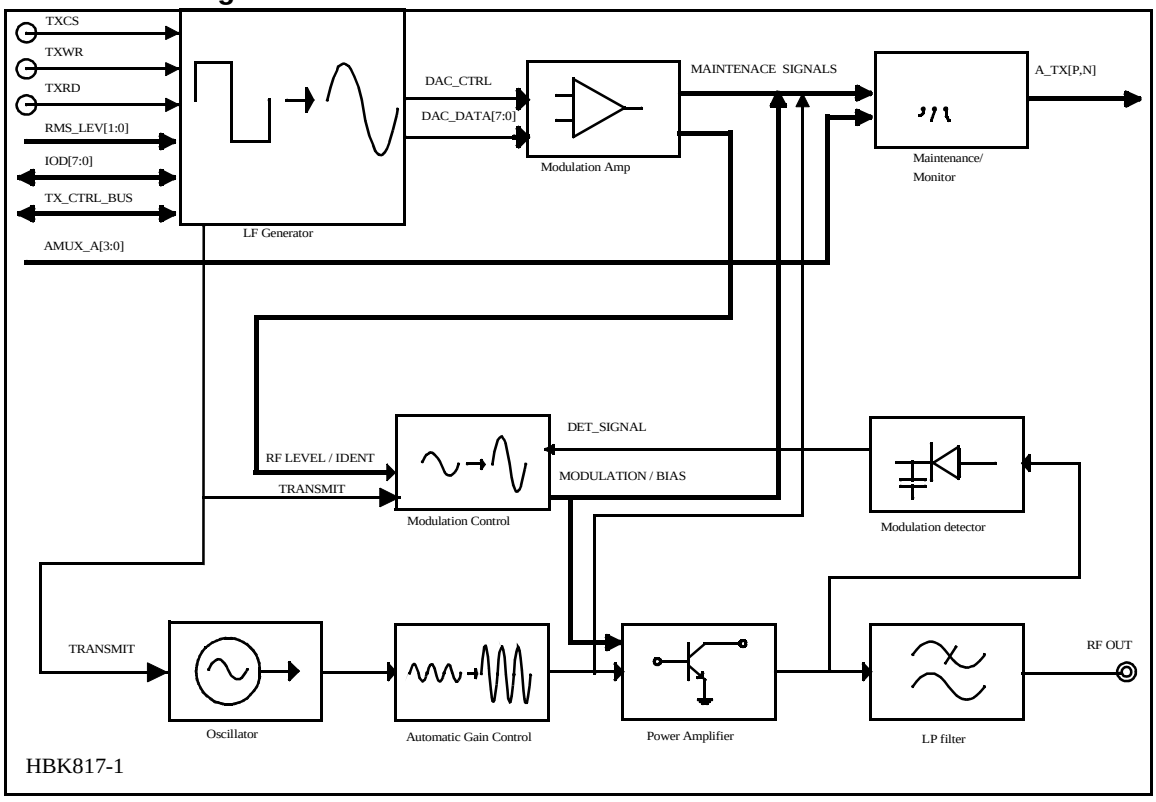


Figure 1-1 TX1373 Block diagram

1.1.2 Signals

(See block diagram Figure1-1)

In	From	Description
IOD[7:0]	MO 1374	Parellel data bus for communication between TX 1/2, CI and MO1
~TXCS	MO 1374	Transmitter card select
~TXWR	MO 1374	Write strobe for IO bus
~TXRD	MO 1374	Read strobe for IO bus
TX_ADR	CI 1376	Transmitter select
TX_ON	MO 1374	Transmitter on/off
AMUX_A[3:0]	MO 1374	Used to select measurement
~RMS_LEV[1:0]	MO 1374	Signals access level for RMS

Out	In	Description
RF_OUT	Antenna	Radio signal
~TX_FB	MO 1374	Signal tells monitor that transmitter is active
A_TX[P,N]	RMS	RMS analogue test signals
~TXCSB	MO 1374	Transmitter card select back

Bidirectional	To/From	Description
TX_CTRL_BUS	MO 1374	Changeover Control (TX_ADR), transmitter on/ off (TX_ON), card select back (TXCSB), feed back (TX1/2_FB)

Power in	From	Description
V20P	PS 1375	+20 VDC to PA
V12P	PS 1375	+12 VDC
VDD	PS 1375	+5 VDC
GND	PS 1375	Analogue ground
V12N	PS 1375	-12 VDC

1.1.3 Building blocks

(See block diagram Figure1-1)

OSCILLATOR

The oscillator is controlled by the Transmit signal from the LF generator. When Transmit is low, a controllable voltage generator turns the internal oscillator 12V voltage on. +12 VDC is then applied to the collector of a bipolar transistor, which is the active device of the oscillator. A 75 MHz crystal is connected in the feedback path together with a resonance circuit.

The output signal is amplified to approximately 0 dBm through a RF gain block.
Signals in: ON/OFF to switch oscillator on.
Signals out: RF to AGC

AUTOMATIC GAIN CONTROL

The AGC circuitry is designed to adjust the signal level from the oscillator to the PA. The signal from the oscillator is fed to one of the ports of a dual gate MOSFET. The signal enters the

PA after being amplified, while part of it is fed back to the other port of the MOSFET. The transistor detects the difference between these two signals and increases or decreases the signal out to the PA, depending on the signal levels from the oscillator.

Signals in:7 5 MHz RF from oscillator.
Signals out: RF to PA, app. +20 dBm
DRV_AGC: control voltage to monitor.

POWER AMPLIFIER

The Power Amplifier stage is implemented by three cascaded stages, with the two first

being bipolar MRF 553 transistors that are collector modulated. The modulation voltage is 0-12VDC both at stage one and stage two. With an input signal from oscillator / AGC of +20 dBm, the first stage will deliver +30 dBm peak power with a dynamic range of 25 dB. A 10 dB resistive π-attenuator is inserted before stage two. The input to the second stage will then be +20 dBm. After amplification and modulation, the peak power will be +30 dB, but the dynamic range is increased to 50 dB. The last stage is a MRF 171 MOSFET transistor designed to deliver high power output. It is biased by 1mA and +20VDC drain voltage. After amplification, the peak power will be +43 dBm with a dynamic range of 75-80 dB.

The TX is capable of delivering 4W carrier power.

Signals in: 75 MHz RF from oscillator / AGC.
Modulation voltages, up to +12VDC.
Power Supply, +20 VDC.
Bias, 0-5 V, to power stage.
Signals out: RF to detector / LP Filter.

LOW PASS FILTER

The output signal from the PA is filtered to remove harmonic frequencies. The filter is a seven pole passive lowpass filter.

Signals in: 75 MHz RF PA.
Signals out: RF to CI 1376.

MODULATION DETECTOR

Part of the output signal is demodulated for feedback and self test purposes. The signal is tapped out via a hybrid coupler to avoid destructive coupling from the detector to the output signal and make sure the detected signal is good. The detection is achieved by a mixer and linear detector. The output is used both as feedback to the modulation control circuitry, and sent to the monitoring circuit where RF level and keying envelope are detected.

Signals in: RF_In from PA.
Signals out: DET_SIGN to modulation control circuitry.
LO_LEVEL to monitor.

LF-GENERATOR

A Field Programmable Gate Array (FPGA) clocked by a 4.9152 MHz oscillator, EEPROM and other digital circuits generate the LF signals. The generated LF frequency is a square wave that is converted to a sinusoidal signal by filtering off the higher order harmonics. The main

inputs to the FPGA are the strapped signals used to select outer, middle, inner or FAN marker frequency, as well as status signals regarding oscillator, RF- and LF-level output. Communication with the FPGA is done by the IOD[7:0], ~TXRD and ~TXWR signals. Multiplying DAC's are used to adjust RF level and modulation depth. The keyed LF signal and the RF level is applied to the Modulation Control Circuits. The modulation voltages to the PA is generated by the use of these signals as well as the ON/OFF signal from the AGC and the detected signal from the PA.

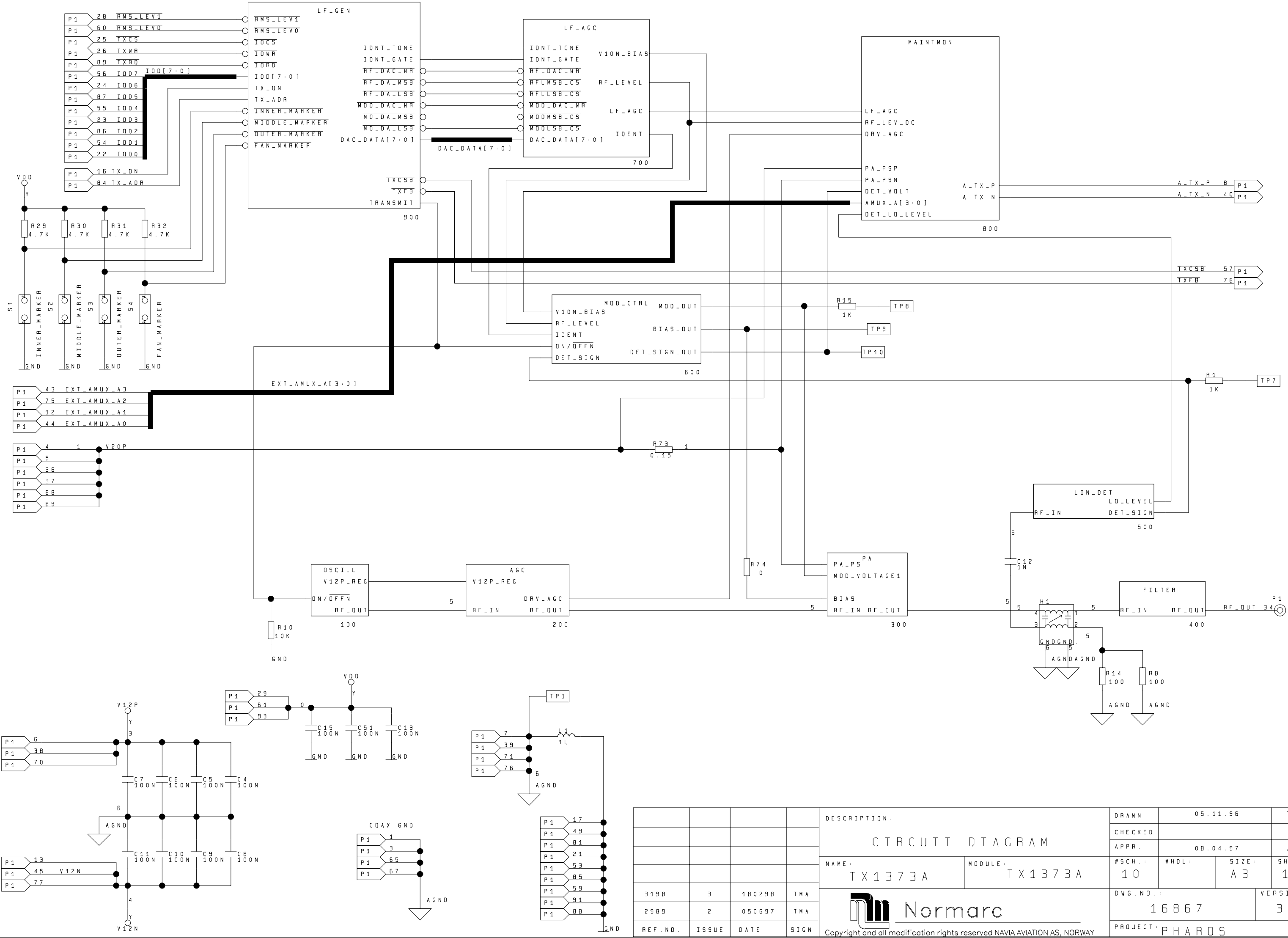
MAINTENANCE / MONITOR CIRCUITRY

The purpose of the onboard monitor circuitry is to give the Monitor card MO 1374 information about the status of the transmitter. The AMUX_ADR[3:0] from the MO 1374 is applied to the analogue multiplexer. These four lines select one of sixteen possible signals to be measured.

The signals measured are:
- PA 20 VDC supply voltage
- PA current drain @ 20 VDC
- Detected RF level from demodulator
- Keying envelope from demodulator
- Positive/negative modulation peaks
- LF AGC voltage
- Driver AGC voltage
- RF level DC voltage from LF generator
- Supply voltage status

The signal information is sent to the MO 1374 monitor unit as a differential analogue test signal from the MUX.

1.2 Schematics



3198	3	180298	TMA
2989	2	050697	TMA
REF.NO.	ISSUE	DATE	SIGN

DESCRIPTION: CIRCUIT DIAGRAM

NAME: TX1373A

MODULE: TX1373A

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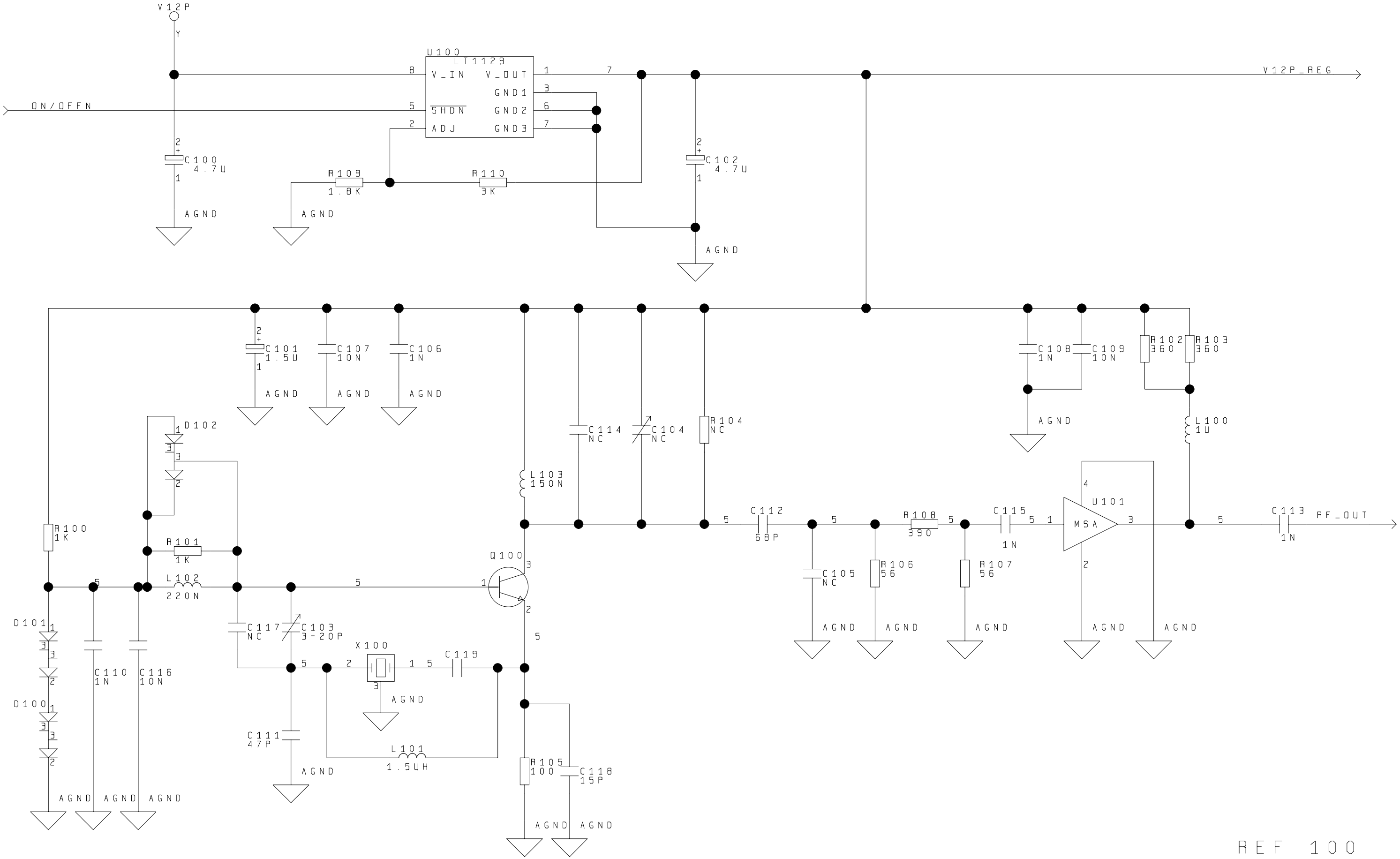
CHECKED			
APPR.	08.04.97		JSA
#SCH.: 10	#HDL.:	SIZE: A3	SHEET: 1
DWG.NO.: 16867			VERSION: 3
PROJECT: PHAROS			

Normarc



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					APPR.	08.04.97	JSA
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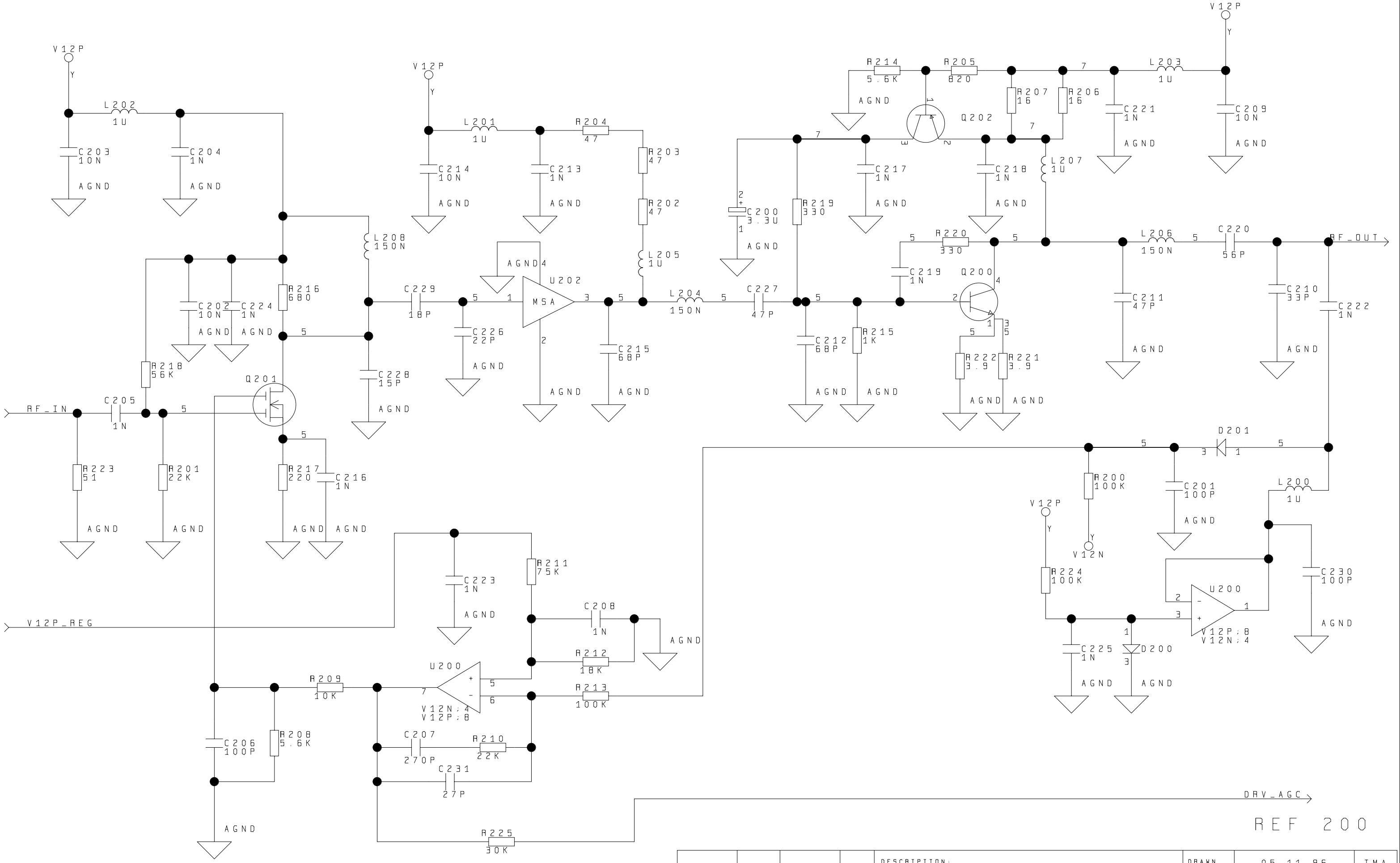
2989	2	050697	TMA		PROJECT:		
REF.NO.	ISSUE	DATE	SIGN				



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				DESCRIPTION: CIRCUIT DIAGRAM		DRAWN	05.11.96 TMA
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						APPR.	08.04.97 JSA
				NAME: AGC	MODULE: TX1373A	#SCH.: 10	#HDL: SIZE: A3 SHEET: 3
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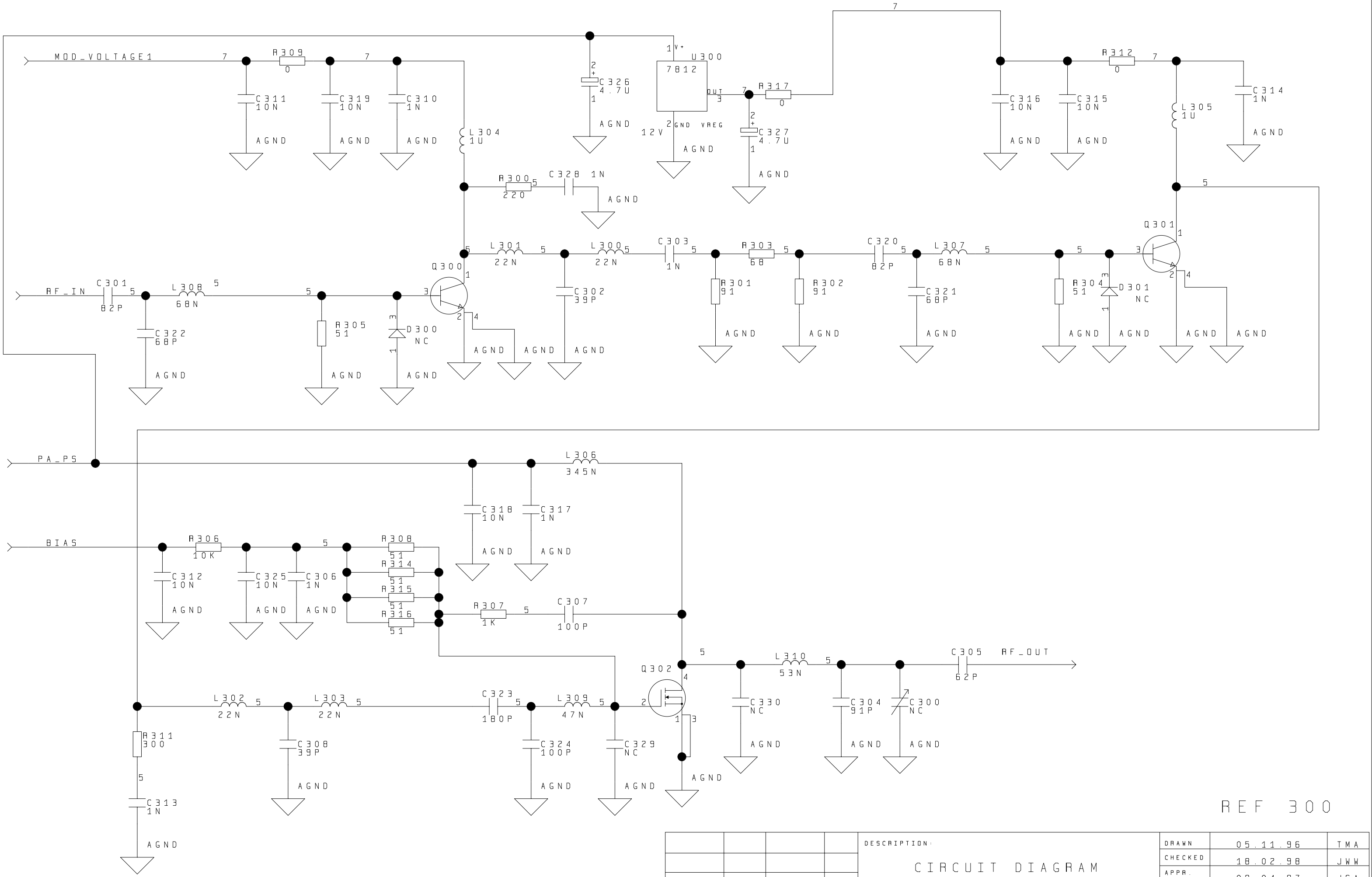
2989	2	050697	TMA			PROJECT:	
REF.NO.	ISSUE	DATE	SIGN				



REF 300

				DESCRIPTION: CIRCUIT DIAGRAM	DRAWN	05.11.96 TMA
					CHECKED	18.02.98 JWW
					APPR.	08.04.97 JSA
				NAME: PA / MODULE: TX1373A	#SCH.: 10 / #HDL: / SIZE: A3 / SHEET: 4	
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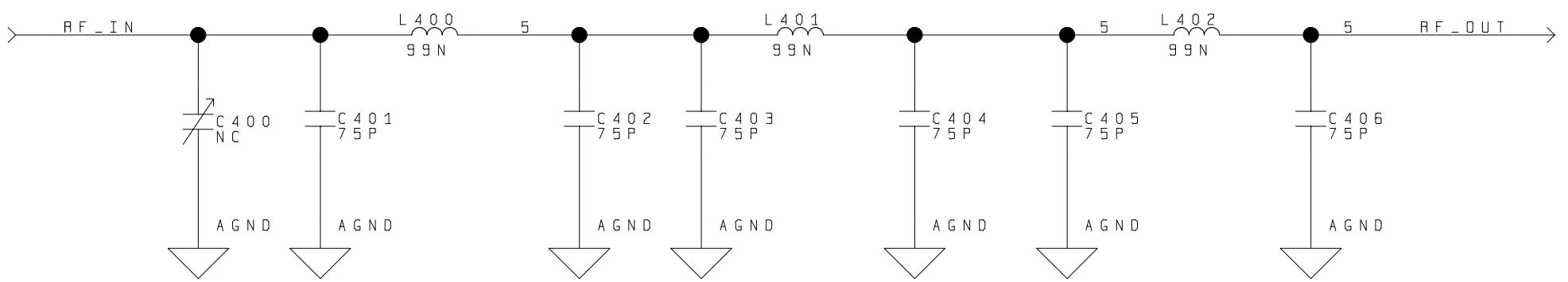
2989	2	050697	TMA		PROJECT:	
REF.NO.	ISSUE	DATE	SIGN			



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					APPR.	08.04.97	JSA
				NAME: FILTER / MODULE: TX1373A	#SCH.: 10	#HDL:	SIZE: A3 / SHEET: 5
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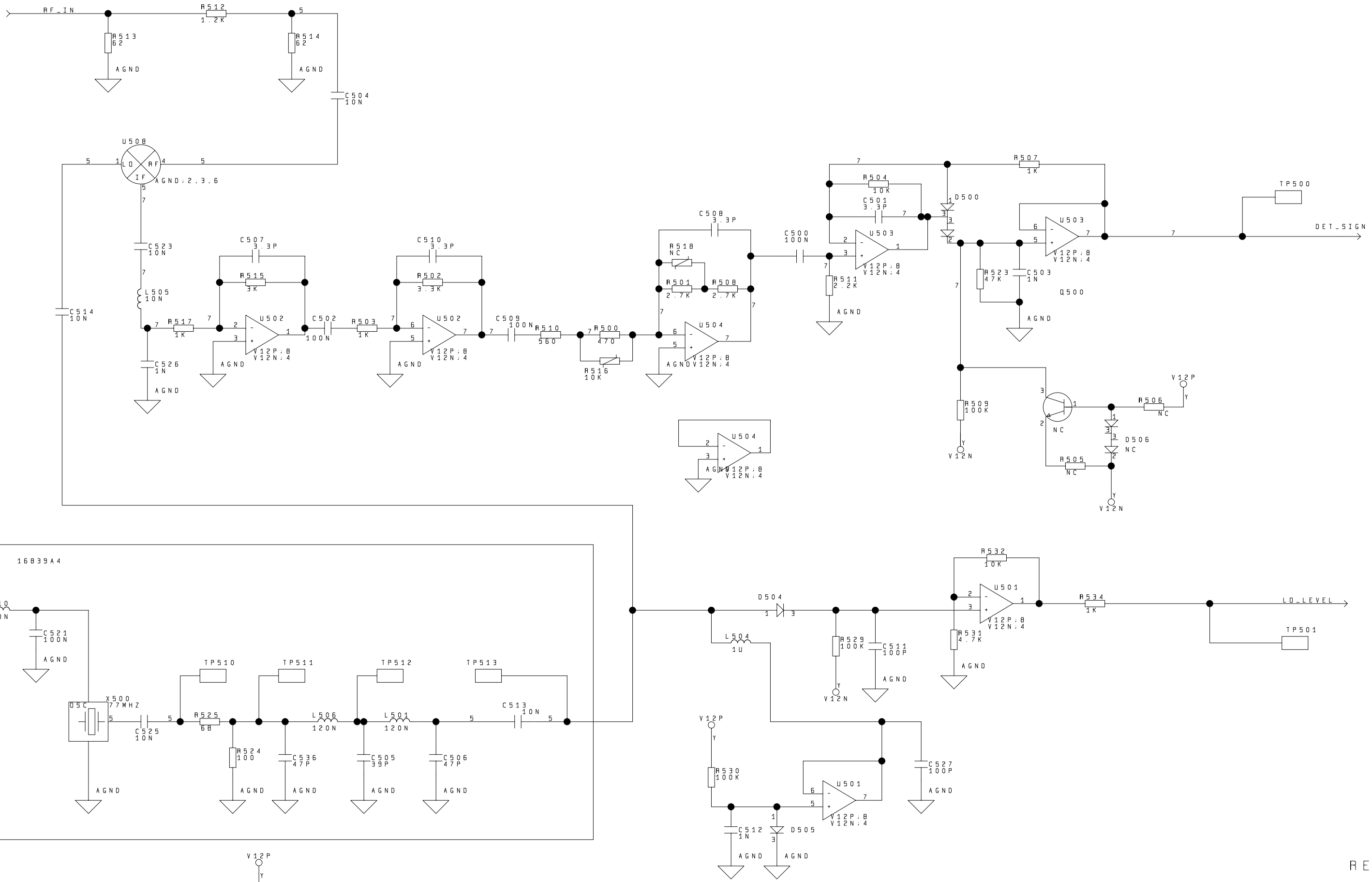
2989	2	050697	TMA				
REF.NO.	ISSUE	DATE	SIGN		PROJECT:		



REF 500

3198	3	180298	TMA
2989	2	050697	TMA
REF.NO.	ISSUE	DATE	SIGN

DESCRIPTION: CIRCUIT DIAGRAM

NAME: LIN_DET

MODULE: TX1373A

DRAWN	05.11.96		TMA
CHECKED	18.02.98		JWW
APPR.	08.04.97		JSA

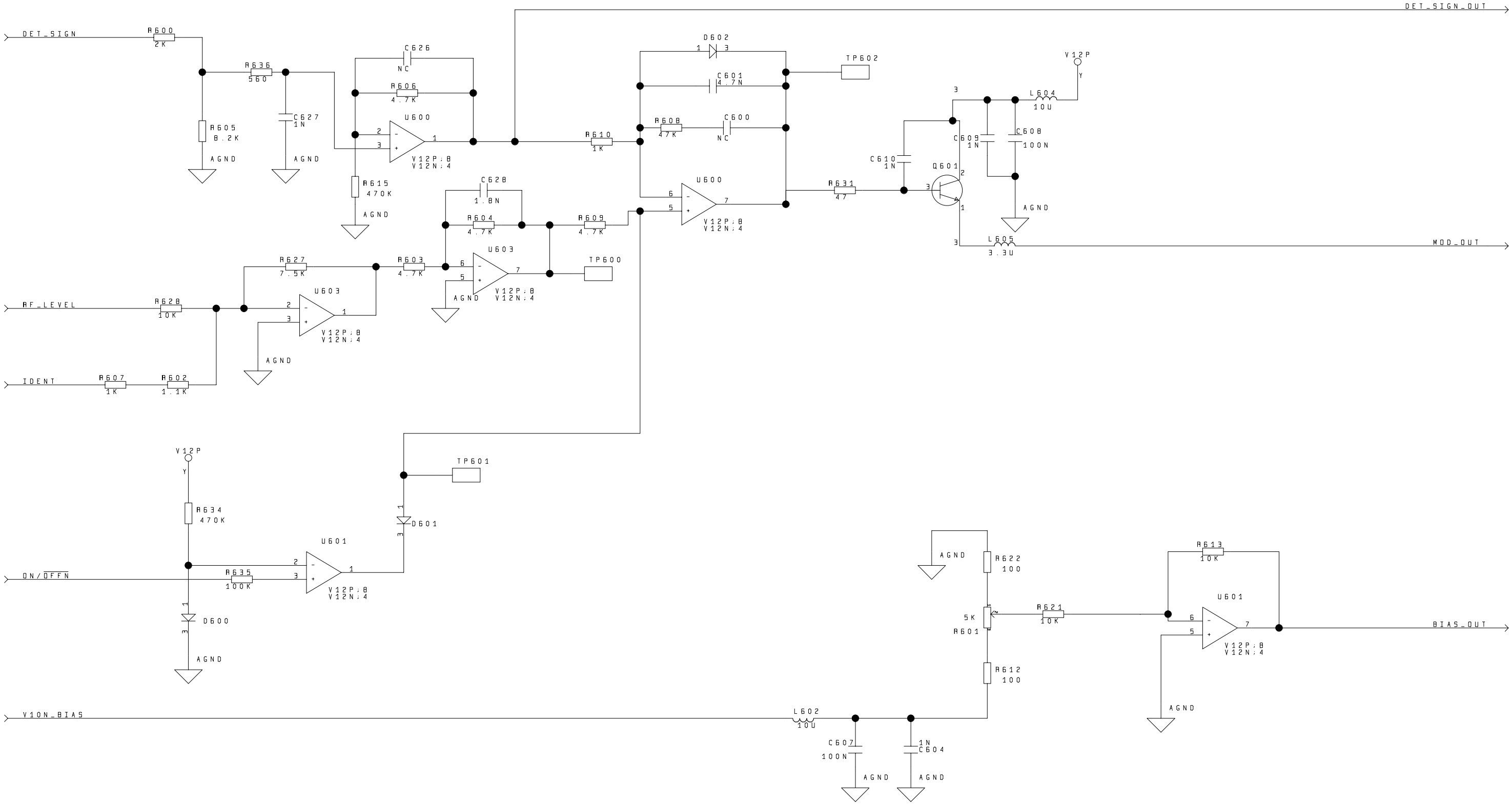
#SCH.	#HDL	SIZE	SHEET
10		A3	6

DWG.NO.: 16867

VERSION: 3

PROJECT: PHAROS

Normarc



REF 600

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					APPR.	08.04.97	JSA
				NAME: MOD_CTRL / MODULE: TX1373A	#SCH.: 10	#HDL.:	SIZE: A3 / SHEET: 7
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2989	2	050697	TMA		PROJECT: PHAROS		
REF.NO.	ISSUE	DATE	SIGN				

DAC_DATA[7:0]

V10N_BIAS

RFLMSB_CS
RFLLSB_CS
RF_DAC_WR

MODMSB_CS
MODLSB_CS
MOD_DAC_WR

IDNT_TONE
IDNT_GATE

U703 7548
U702 7548
U705 REF08
U704 4.7U C700
U706 509
U700 V12N;13 V12P;4
U701 V12N;13 V12P;4

R700 10K
R701 10K
R702 1.5K
R703 1.5K
R704 47K
R705 56K
R706 1MEG
R707 33K
R708 22K
R709 68
R710 10K
R711 68
R712 47K
R713 10K
R714 68K
R715 33K
R716 10K
R717 1.8K
R718 1.5K
R719 1.5K
R720 1.5K
R721 30K
R722 7.5K

C700 4.7U
C701 330N
C702 1U
C703 100P
C704 680P
C705 33P
C706 33P
C707 1U
C709 100N
C710 100N
C711 10N
C712 100N
C713 100N
C714 100N
C715 10N
C716 10N

D700

TP700 IDENT
TP701
TP702
TP703 RF_LEVEL
TP704

LF_AGC

REF 700

3198	3	180298	TMA
2989	2	050697	TMA
REF.NO.	ISSUE	DATE	SIGN

DESCRIPTION: CIRCUIT DIAGRAM

NAME: LF_AGC

MODULE: TX1373A

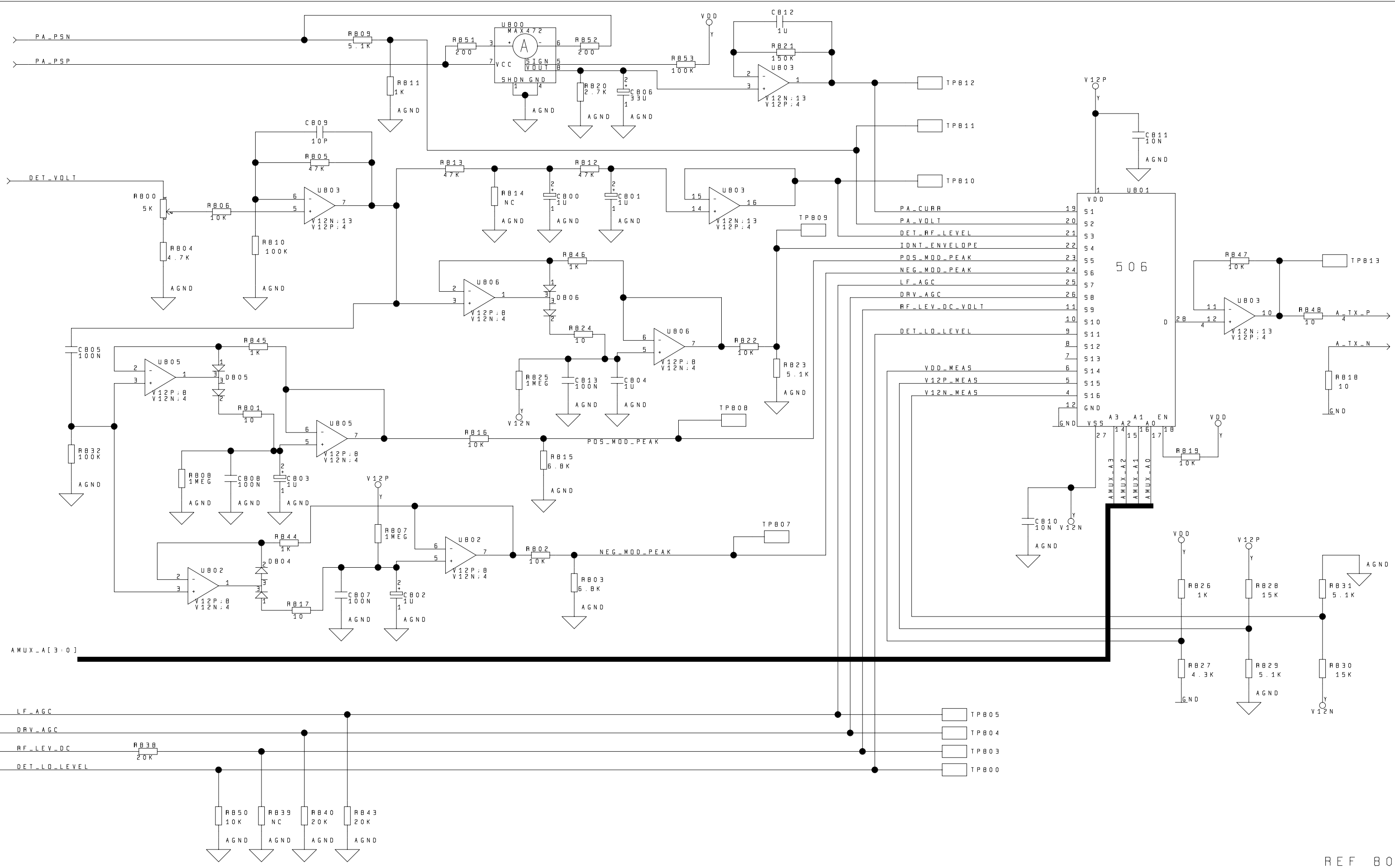
DRAWN	05.11.96		TMA
CHECKED	18.02.98		JWW
APPR.	08.04.97		JSA
#SCH.: 10	#HDL:	SIZE: A3	SHEET: 8

DWG.NO.: 16867

VERSION: 3

PROJECT: PHAROS

Normarc



REF 800

3198	3	180298	TMA
2989	2	050697	TMA
REF.NO.	ISSUE	DATE	SIGN

DESCRIPTION: CIRCUIT DIAGRAM

NAME: MAINTMON

MODULE: TX1373A

Normarc

DRAWN	05.11.96		TMA
CHECKED	18.02.98		JWW
APPR.	08.04.97		JSA
#SCH.: 10	#HDL.:	SIZE: A3	SHEET: 9
DWG.NO.: 16867			VERSION: 3
PROJECT: PHAROS			

NMP124A
TPC1020AFN084I

U905

IMO1	14	IMO1	
IMO0	16	IMO0	
KEY_FRQ	30		
KEY_GATE	83		
DAC_DATA7	20	DAC_DATA7	
DAC_DATA6	23	DAC_DATA6	
DAC_DATA5	63	DAC_DATA5	
DAC_DATA4	22	DAC_DATA4	
DAC_DATA3	65	DAC_DATA3	
DAC_DATA2	21	DAC_DATA2	
DAC_DATA1	64	DAC_DATA1	
DAC_DATA0	69	DAC_DATA0	
RF_DAC_WR	5	RF_DAC_WR	
RF_DA_MSB	10	RF_DA_MSB	
RF_DA_LSB	11	RF_DA_LSB	
MOD_DAC_WR	7	MOD_DAC_WR	
MO_DA_MSB	13	MO_DA_MSB	
MO_DA_LSB	15	MO_DA_LSB	
EEPR_DATA7	28	ED7	
EEPR_DATA6	58	ED6	
EEPR_DATA5	57	ED5	
EEPR_DATA4	59	ED4	
EEPR_DATA3	50	ED3	
EEPR_DATA2	49	ED2	
EEPR_DATA1	45	ED1	
EEPR_DATA0	44	ED0	
EEPR_ADR9	1		
EEPR_ADR8	84		
EEPR_ADR7	9		
EEPR_ADR6	8		
EEPR_ADR5	6		
EEPR_ADR4	17		
EEPR_ADR3	3		
EEPR_ADR2	2		
EEPR_ADR1	77		
EEPR_ADR0	71		
EEPR_WE	75		
EEPR_OE	56		
TRANSMIT	52		
TXFB	70		
TXCSB	55		
FILT_TONE	79		
RMS_LEV1	78	RMS_LEV1	
RMS_LEV0	81	RMS_LEV0	
INNER_MARKER	29	INNER_MARKER	
MIDDLE_MARKER	32	MIDDLE_MARKER	
OUTER_MARKER	31	OUTER_MARKER	
FAN_MARKER	27	FAN_MARKER	
TX_ON	38	TX_ON	
TX_ADR	51	TX_ADR	
IOCS	62	IOCS	
IORD	35	IORD	
IOWR	54	IOWR	
IOD7	34	IOD7	
IOD6	37	IOD6	
IOD5	41	IOD5	
IOD4	24	IOD4	
IOD3	47	IOD3	
IOD2	48	IOD2	
IOD1	43	IOD1	
IOD0	42	IOD0	
CLKIN	80		
PWR_RST	76		

VDD: 4, 25, 26, 33, 46, 67, 68
GND: 18, 19, 40, 60, 61, 66, 82

RP900 10K
1N R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 R11 R12 R13 R14 R15
16 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

IMO[1:0]
IDNT_GATE
DAC_DATA[7:0]
ED[7:0]
IOD[7:0]

U902 28C64

GND	14		
A12	2		
A11	23		
A10	21		
A9	24		
A8	25		
A7	3		
A6	4		
A5	5		
A4	6		
A3	7		
A2	8		
A1	9		
A0	10		
WE	27		
OE	22		
CE	20		
NC	26		
NC	1	GND	
IO7	19	ED7	
IO6	18	ED6	
IO5	17	ED5	
IO4	16	ED4	
IO3	15	ED3	
IO2	13	ED2	
IO1	12	ED1	
IO0	11	ED0	
VDD	28		

U901 VCC 693

VBATT	1	LOWLINE	6
OSCIN	7	BATTON	5
OSCSEL	8	VOUT	2
PFI	9	RESETN	15
WDI	11	RESET	16
CEIN	13	PFO	10
		CEOUT	12
		WDO	14
GND	4		
VDD	3	WDG	

X900 OSC 4.9152MEGHZ CLK
TP900
TP902
TP901
C908 100N
C915 10N
C916 10N
C917 10N
C918 10N
C919 1U
R900 200K
R901 10K
R902 1MEG
R903 180K
R904 240K
R905 43K
R906 3K
R907 75K
R908 200K
R909 100K
R910 39K
R911 15K
R912 10K
R913 75K
R914 10K
R915 10K
R916 10K
R917 200K
C900 470P
C901 470P
C902 3.3N
C903 1N
C904 3.3N
C905 470P
C906 470P
C907 10N
C909 3.3N
C910 3.3N
C911 1N
C912 470P
C913 10N
C914 1N

U903 509

VDD	14		
IN3A	7		
IN2A	6		
IN1A	5		
IN0A	4		
IN3B	10		
IN2B	11		
IN1B	12		
IN0B	13		
GND	15		
DA	8		
DB	9		
VSS	3		
A1	16		
A0	1		
EN	2		

U904 509

VDD	14		
IN3A	7		
IN2A	6		
IN1A	5		
IN0A	4		
IN3B	10		
IN2B	11		
IN1B	12		
IN0B	13		
GND	15		
DA	8		
DB	9		
VSS	3		
A1	16		
A0	1		
EN	2		

U900

-	6		
+	5		
	7		

V12P; 8
V12N; 4

U906 2903

+	3		
-	2		
	1		

V12P; 8
AGND; 4

IMO[1:0]
FILT_TONE
IDNT_TONE

REF 900

REF. NO.	ISSUE	DATE	SIGN
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2989	2	050697	TMA

DESCRIPTION: CIRCUIT DIAGRAM

NAME: LF_GEN
MODULE: TX1373A

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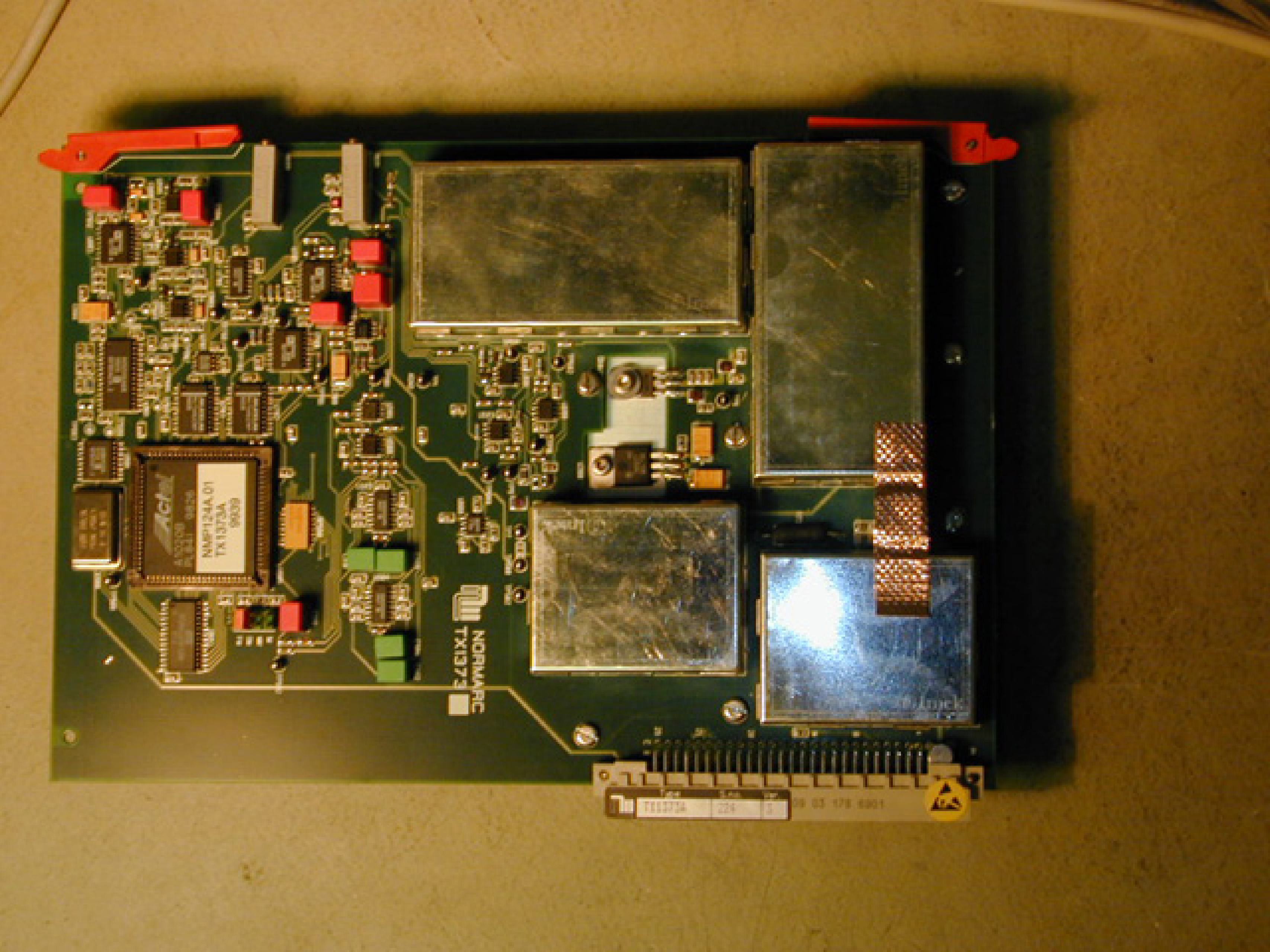
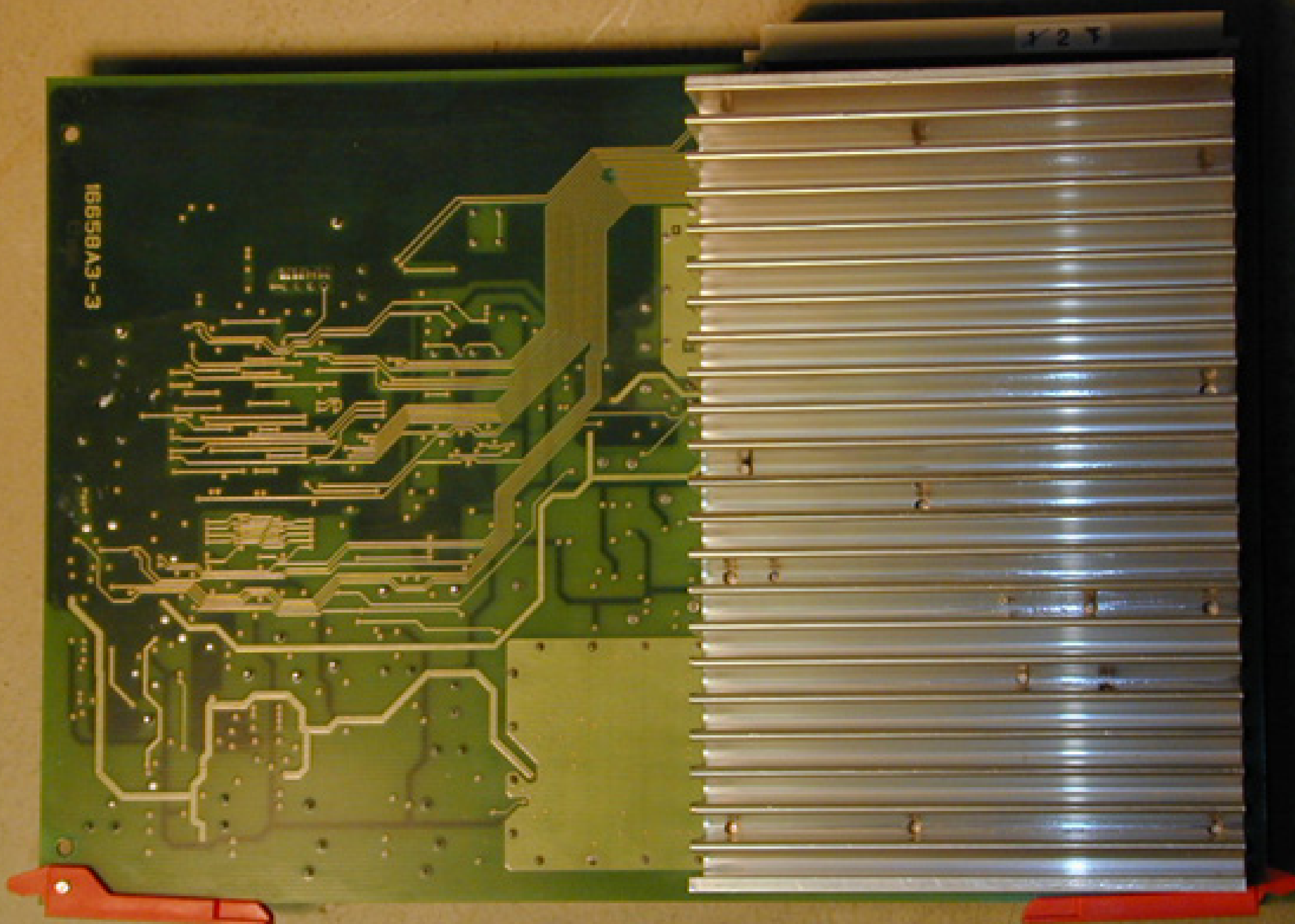
CHECKED	18.02.98	JWW	
APPR.	08.04.97	JSA	
#SCH.: 10	#HDL:	SIZE: A3	SHEET: 10
DWG.NO.: 16867		VERSION: 3	

Normarc

PROJECT: PHAROS

1.3 Photos


NORMARC
TX1373


16658A3-3

2 Tests and adjustments

2.1 Preparations

Terminate the RF OUT terminal with a 50Ω load (antenna or dummy). The transmitters are factory adjusted to 2 watt output power. Let both transmitters run for ½ hour at this power to achieve a stable working temperature before any fine tuning is carried out.

2.2 Configuration settings

Follow this procedure to set the configurations in the Marker Beacon according to desired system configuration.

2.2.1 General Configuration

The static control strap on the Connection interface board sets hardware configuration, remote access configuration and shutdown configuration. Figure 2-1 shows where the static control strap is located on CI 1376.

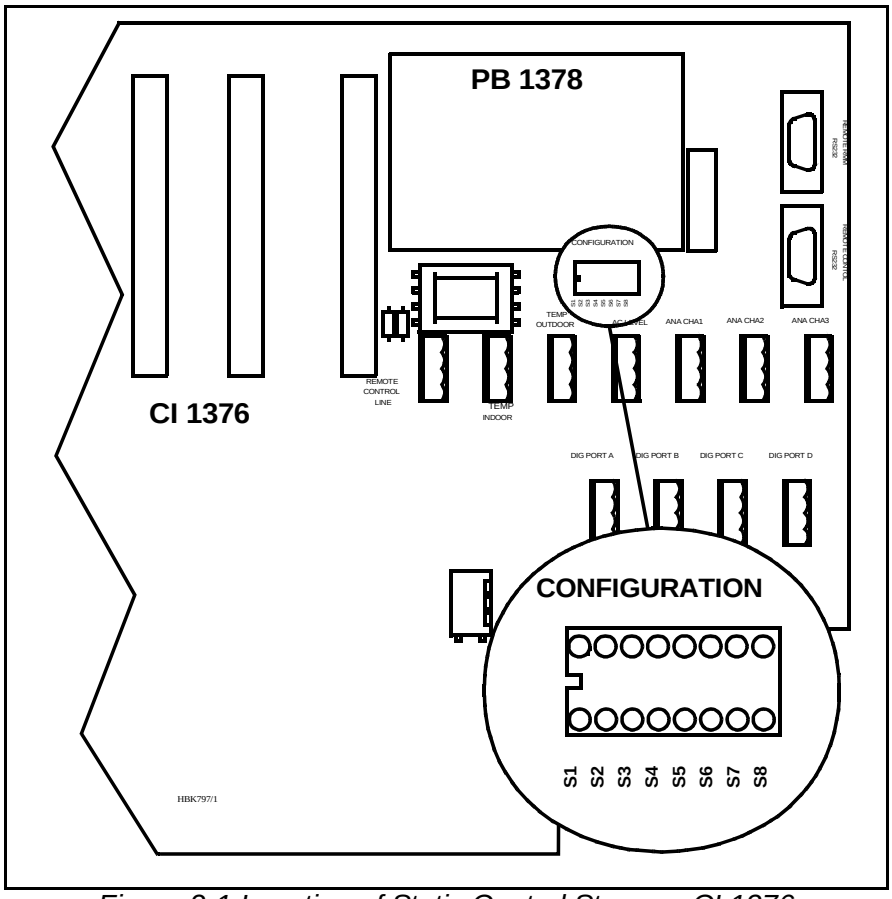


Figure 2-1 Location of Static Control Strap on CI 1376

Set the configuration for the MB according to Table 2-1.

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Strap no	State	Function
S1	Strap **IN**	2 power supplies *(NM 7050 B/D)*
	Strap **OUT**	1 power supply *(NM 7050 A/C)*
S2	Strap **IN**	Access Grant disabled
	Strap **OUT**	Access Grant enabled
S3	Strap **IN**	2 monitor units *(NM 7050 C/D)*
	Strap **OUT**	1 monitor unit *(NM 7050 A/B)*
S4	Strap **IN**	Lost contact with remote control will NOT cause shutdown
	Strap **OUT**	Lost contact with remote control will cause shutdown
S5	Strap **IN**	Standby transmitter failure will NOTcause shutdown
	Strap **OUT**	Standby transmitter failure will cause shutdown
S6	Strap **IN**	Access level 2 on RMM remote port enabled
	Strap **OUT**	Access level 2 on RMM remote port disabled
S7	Strap **IN**	Access level 3 on RMM remote port enabled
	Strap **OUT**	Access level 3 on RMM remote port disabled
S8		Should always be left open.

Table 2-1 MB Configuration settings

S1 and S3 will decide the model (NM 7050 A, B, C or D) and show up in the **Link Status** window in the RMM program and the **Initial Window** in the LCD menu. A disagreement between the settings and the actual number of modules will cause a *MAINTENANCE WARNING* on the **Front Panel** and an *ERROR* in the **Maintenance** window.

With S2 = *IN* the ACCESS GRANT switch on the **Remote Control** will have no effect. You may still acquire *ACCESS LEVEL 2* and *3* on the **RMM remote port** if the settings of S6 and S7 permits.

S4 decides weather lost communication with the **Remote Control** will cause shutdown (no TX to air) or not.

S5 instructs the transmitter control software weather a failed standby transmitter will be shut down or continue to transmit.

S6 and S7 decides the highest ACCESS LEVEL permitted on the **RMM remote port**. All access levels are available on the RMM local port regardless of S6 and S7.

2.2.2 Setting inner, outer or middle marker

To configure the beacon for outer, middle or inner marker set the straps (S1-S4) on the transmitter board(s) according to Table 2-2.

Strap	Function with strap in
S1	Beacon is INNER marker
S2	Beacon is MIDDLE marker
S3	Beacon is OUTER marker
S4	Beacon is FAN marker

Table 2-2 Marker function configuration

Figure 2-2 shows where the straps are located on the transmitter board(s).

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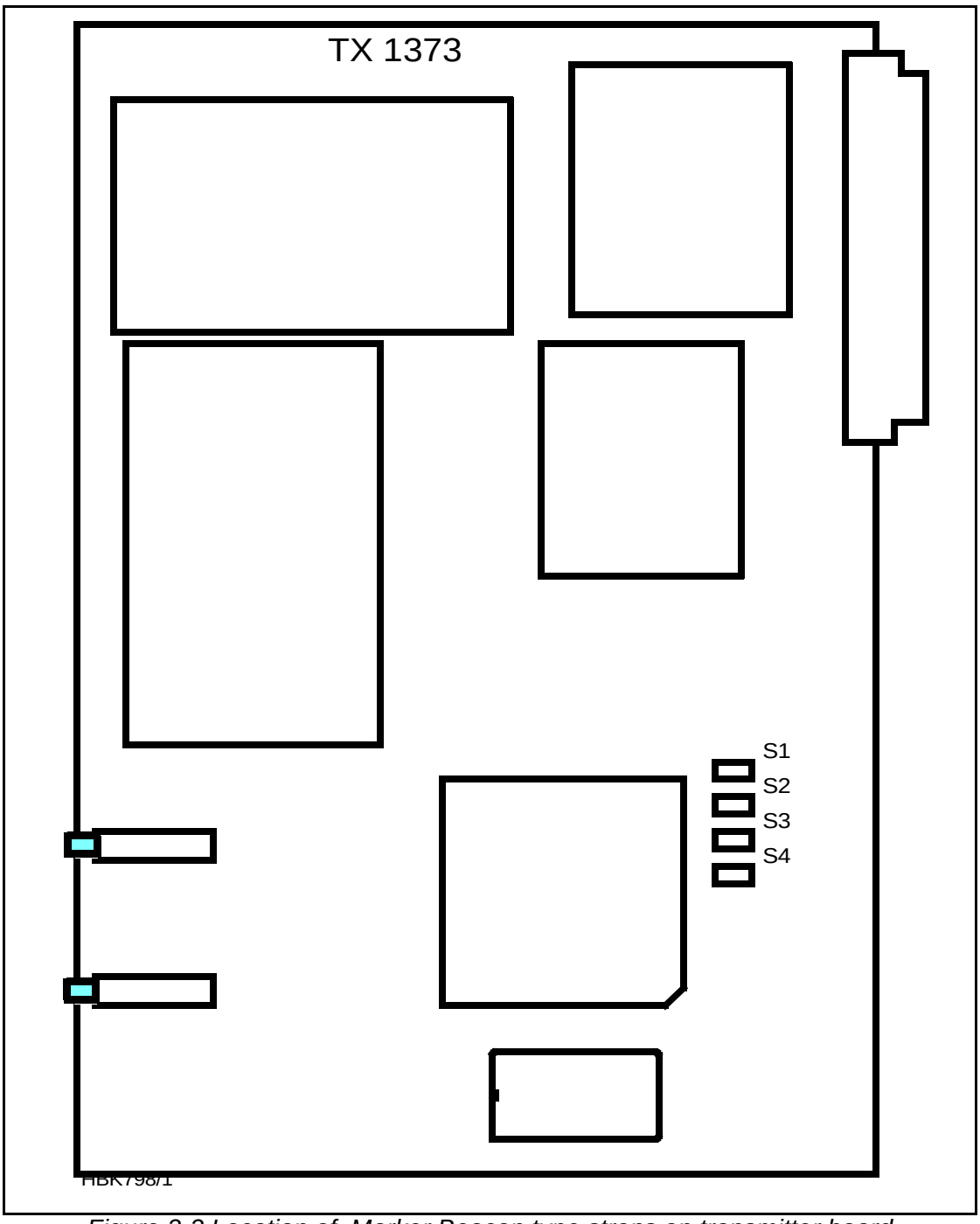

Figure 2-2 Location of Marker Beacon type straps on transmitter board

2.3 Adjustment points

The adjustment points are shown in Figure 2-3 and explained below. The figure shows a fully equipped system, NM 7050D, see chapter 3 for configuration details:

1. Battery charging voltage (nom 27.4V@20°C)
1. Bias for power transistor (use factory settings)
1. Battery protection cut-off voltage (nom. 22V)
1. Tx Detected Rf level (nom. 2.5V@4W carrier)

1. Monitor RF level (nom. 3V@nominal output power)
1. Monitor frontend input filter centre frequency (use factory settings)
2. Real time clock fine tuning(use factory settings)

The adjustment points marked *Use Factory Settings* should not be touched.
The baseband level has to be adjusted at installation.
The other are factory pre-set but may be adjusted.

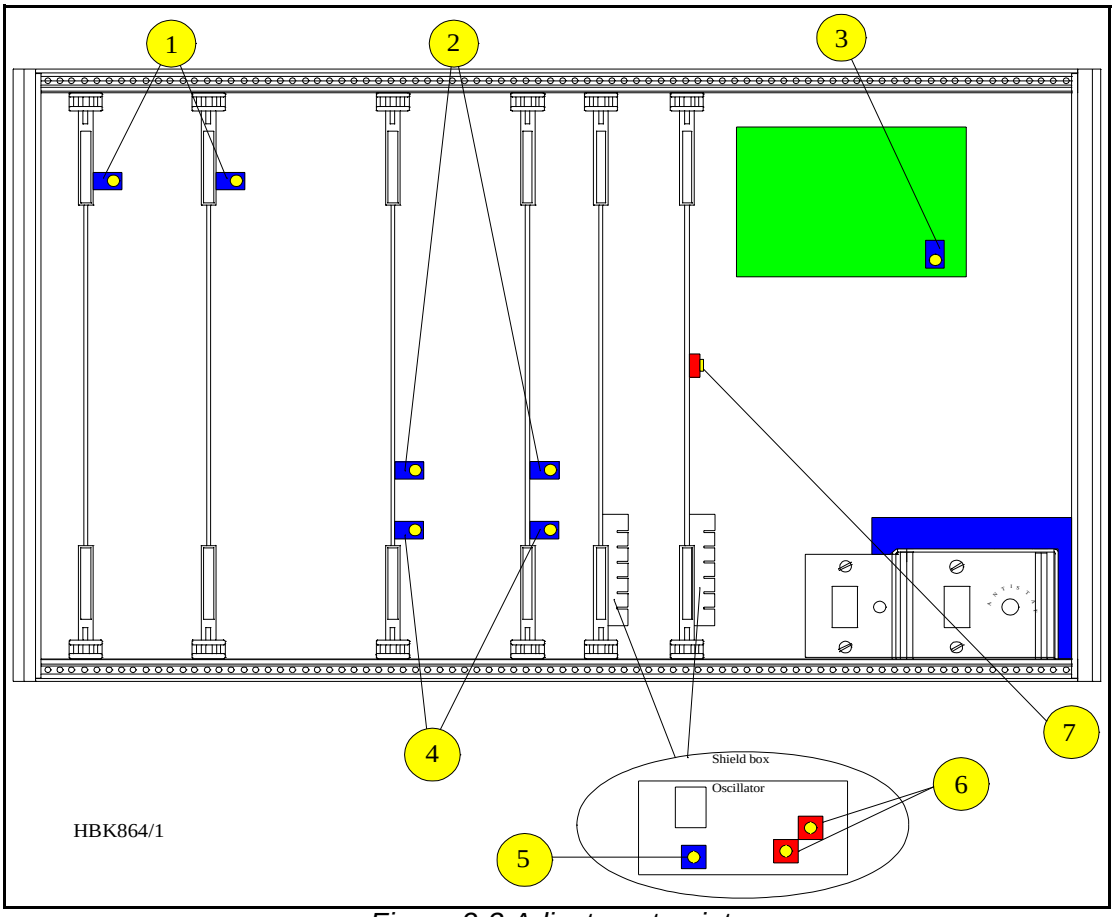

Figure 2-3 Adjustment points

2.4 Adjustments at installation

These procedures have to be carried out at installation in order to set up your equipment right.

2.4.1 Transmitter output power adjustment

This adjustment is most easily done with the RMM PC program but the local keyboard/display may be used.

- Make sure the output signal RF OUT is terminated with a 50Ω load (antenna or dummy load).
- If this is an Inner Marker make sure the external attenuator is installed.
- Start the RMM program on the PC (see chapter 10)
- Open the **TX settings** window, RF LEVEL for TX1 and TX2 are to be adjusted.
- Open the **Maintenance** window. RF LEVEL for TX1 and TX2 are to be watched.

- Set *LOCAL* mode with the REMOTE/LOCAL switch.
- Set *MANUAL* mode with the AUTO/MANUAL switch.
- Set *TX1* to air with the CHANGEOVER button
- Adjust RF LEVEL in **TX settings** until you read the desired output power on RF LEVEL in **Maintenance**.
- Check that you read the desired modulation depth in **Maintenance**.
- Set *TX2* to air and repeat the two previous steps.

2.5 Other adjustments

These adjustments are normally not required, the factory settings should be sufficient.

2.5.1 Output power readout calibration

The CARRIER POWER parameter in the RMM **Maintenance** window is the internal wattmeter. It is factory calibrated, but may be recalibrated by following this procedure. The software adjustments are most easily done with the RMM program, but may be carried out from the front panel.

- Connect a reference wattmeter to the output signal RF OUT.
- Set TX1 to air.
- Watch the maintenance parameter CARRIER POWER
- Adjust the **TX settings** parameter RF LEVEL until the watt meter shows *2W*
- Check that the **Maintenance** parameter CARRIER POWER on TX1 is accurate to within 5%.
- If not, adjust the **Carrier Power** potentiometer on TX1 until the parameter shows 2.00W
- Repeat for 1W and 0.5W
- Repeat for TX2..

Inner Marker uses an external 10 dB attenuator, use 0.2W, 0.1W and 50mW to calibrate. CARRIER POWER is measured prior to the attenuator, but the software will automatically compensate for the 10dB.

2.6 TX setting through RMM

This view is used to tune the transmitters RF OUTPUT LEVEL, MODULATION DEPTH and KEYING. There are also two test set-ups which are pre-set values used to provoke alarms in maintenance situations.

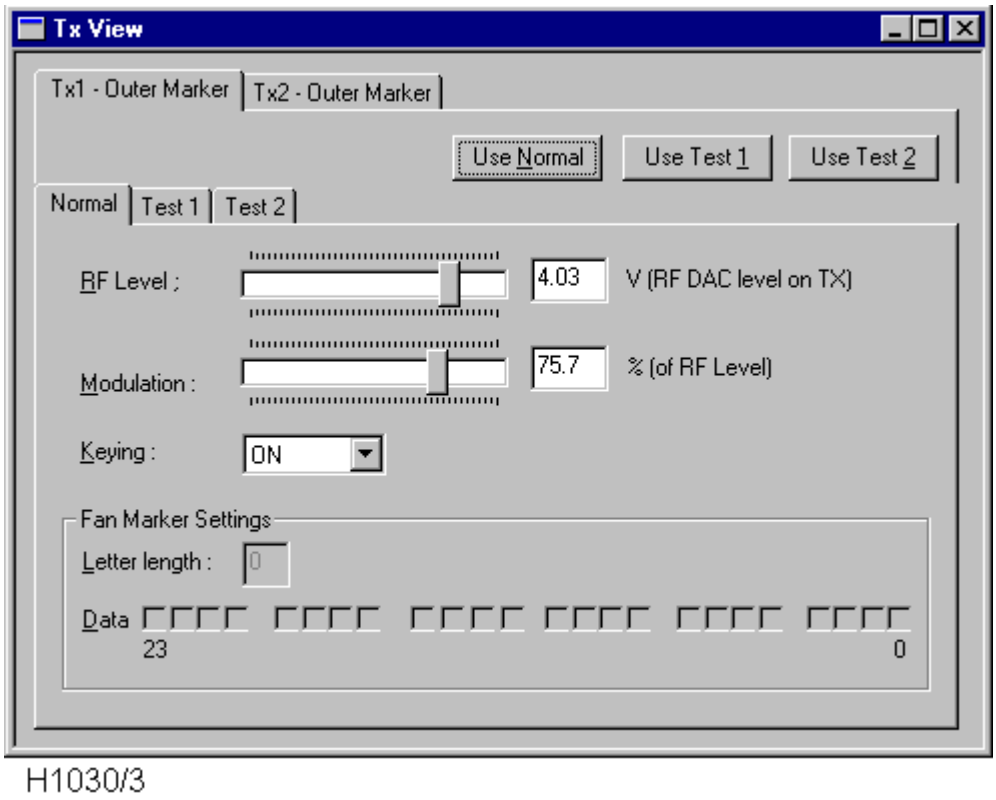

Figure 2-4 The TX settings view

ALTERING VIEWS

- You may select between TX1 and TX2 by clicking the TX1 or TX2 tabs.
- You may select transmitter set-up by clicking the NORMAL, TEST1 or TEST2 tabs.

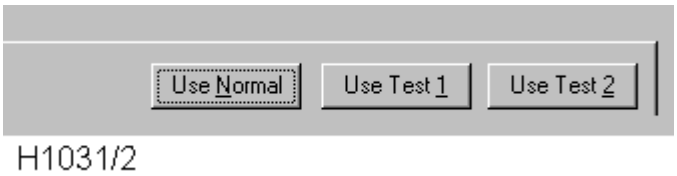

Figure 2-5 Selecting test settings

You may choose between three pre-set transmitter settings by clicking the USE NORMAL, USE TEST 1 or USE TEST 2 buttons.

Note that when leaving access level 2/3, the Normal set-up will be loaded into the transmitters. This is also the case when turning the transmitter from off to on.

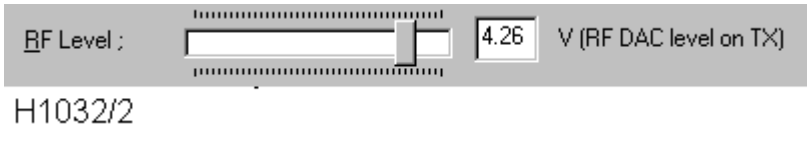

Figure 2-6 Adjusting the RF level

The RF LEVEL (output power) is adjusted by dragging the RF LEVEL knob. The value in volts in the window to the right shows the control voltage to the power amplifier. If you want a power indication in Watts, open the maintenance window and watch the CarrierPower parameter for the selected TX1373.

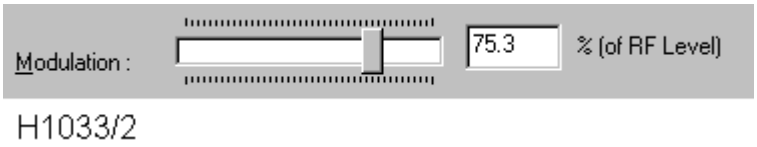

Figure 2-7 Adjusting the modulation depth

Similar to above, the MODULATION DEPTH is adjusted by dragging the MODULATION knob. The value is given in percent. This percentage is not the same as the modulation depth in the monitor, but the percent of the RF Level DAC that is used to feed the modulation circuitry in the transmitter.

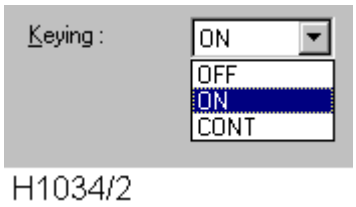

Figure 2-8 Setting keying type

There are three possible keying alternatives: *NORMAL*, *CONTINUOS* and *OFF*, the two latter used for test or maintenance purposes.

FAN MARKER

If the station is configured as a *FAN MARKER*, the keying may be set quite freely. Each of the 24 Data boxes corresponds to one tick which endures for approximately 150ms. An X indicates sound while an empty box indicates silence. LETTER LENGTH is how many ticks are used in a sequence. The table below shows the expected lengths for keying elements:

Keying element	#ticks
Dot	1
Dash	3
Space	1
Letter space	2

Table 2-3 Fan Marker keying elements

Let's say you want to transmit an *X*. Then you should program *DASH-SPACE-DOT-SPACE-DOT-SPACE-DASH-LETTER SPACE*. This gives a LETTER LENGTH of 3+1+1+1+1+1+3+2=*13* as shown in Figure 2-9

Figure 2-9 Fan marker keying programming.

Note that the Fan Marker settings are available only when the transmitter are configured as Fan Marker.